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NOTES ON GEOGRAPHIC DISTRIBUTON

First record of *Anolis sagrei* Dumeril & Bibron, 1837 (Squamata, Anolidae) in Sonora, northwestern Mexico

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Abstract. *Anolis sagrei* is a lizard that naturally occurs on various islands of the Caribbean and in Central America. However, it has also been widely introduced in different countries around the world. In Mexico, it is present in seven states with tropical climate Here, we present the first record of *A. sagrei* from the Mexican state of Sonora.

Key words. Cuban Brown Anole, Ciudad Obregon, exotic species, expansion of distribution, invasive/introduced species, new record

Pérez-Delgadillo AG, Lara-Reséndiz RA (2024) First record of *Anolis sagrei* Dumeril & Bibron, 1837 (Squamata, Anolidae) in Sonora, northwestern Mexico. Check List 20 (1): 132–137. https://doi.org/10.15560/20.1.132

INTRODUCTION

Anolis sagrei Dumeril & Bibron, 1837, Cuban Brown Anole (Figure 1), is a species of lizard native to Cuba, the Bahamas, and associated islets and cays (Campbell and Echternacht 2003; Powell and Henderson 2012). This species is mainly found in the arboreal and semiarboreal strata, although it also shows a preference for scrubland and lowland tropical forests (Álvarez-Romero et al. 2008; Delaney et al. 2014). Beyond its natural distribution, this lizard has been widely introduced either naturally or through human activities in several countries (Fläschendräger 2010). It has been recorded in various locations such as Jamaica and other Caribbean Islands (Powell et al. 2011), Ecuador (Amador et al. 2017), Honduras (McCranie and Nuñez 2014), Panama (Batista et al. 2019), Brazil (Oliveira et al. 2020), Singapore (Tan and Lim 2012), and Taiwan (Norval et al. 2002). In the United States, it is found along the southeastern coast

OPEN ACCESS

Academic editor: Sebastian Lotzkat
Received: 23 July 2023
Accepted: 13 January 2024
Published: 19 January 2024

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Figure 1. *Anolis sagrei*, adult male CH-UABC 2603. **A.** Close-up of the head with the dewlap extended. **B.** In situ photograph in the nursery of Ciudad Obregón, Cajeme, Sonora.

(Campbell and Echternacht 2003; Wiley et al. 2007; Hofmann et al. 2018; Bassett 2022), the southwestern region (Mahrdt et al. 2014), and in the Hawaiian Islands (Krysko and Granatosky 2010). Based on reports in the primary scientific literature, the presence of the *A. sagrei* in Mexico has been documented on the Yucatan Peninsula in the states of Campeche, Quintana Roo, and Yucatan (Calderón et al. 2003; Álvarez-Romero et al. 2008; Charruau et al. 2015; Badillo-Saldaña et al. 2016; Vásquez-Cruz et al. 2020). Additionally, it has been reported in the Gulf of Mexico states of Tabasco (Sánchez 2013; Terán-Juárez et al. 2015), Veracruz (González-Soriano et al. 1997; Zamora-Abrego et al. 2006; Toscano-Flores and Calzada-Arciniega 2015; Venerozo-Tlazalo et al. 2017; Cerón de la Cruz and Vásquez-Cruz 2021; Vásquez-Cruz et al. 2021), and Tamaulipas (Terán-Juárez et al. 2015). Two records exist in the state of Chiapas (Hernández-Vázquez and Munoz-Alonso 2022), and there is a singular record from the Pacific coast in Jalisco state (Pazos-Nava et al. 2019; Vásquez-Cruz et al. 2021) (Figure 2).

In this study, we present the first record of *A. sagrei* in northwestern Mexico, specifically in Ciudad Obregón, Cajeme, Sonora. This discovery constitutes a significant contribution to the knowledge of the distribution of this species and highlights the importance of maintaining constant surveillance of exotic species to safeguard the integrity of local ecosystems. Although this species has been spreading in some areas of southeastern Mexico in recent decades (Pazos-Nava et al. 2019; Vásquez-Cruz et al. 2021), it had not been recorded in regions with drier climates such as the northwest.

METHODS

We made two visits on 25 April and 4 May 2023 to a plant nursery located in Ciudad Obregón, Cajeme, Sonora, Mexico, where the lizards were casually found. We conducted non-systematic searches to observe the lizards and used a fishing rod with a lasso to capture them. The lizards were identified using diagnostic characters, such as elongated postcloacal scales, yellow-orange to red-orange dewlap with a yellow border (Figure 1A), and a laterally compressed tail, as well as uniformly sized supracaudal scales and a dorsal crest of enlarged scales visible mainly in males, following the criteria established by Köhler (2003).

We observed 18 individuals of *A. sagrei* of different ages (adults and juveniles) and photographed of 12 of them (as an example, Figure 1B). We captured and preserved an adult male with a snout–vent length (**SVL**) of 68 mm and a tail length (**TL**) of 115 mm, weighing 6.6 g (Figure 1). The specimen was deposited in the Herpetological Collection of the Universidad Autónoma de Baja California, Ensenada, Mexico (**CH-UABC**), while the photographs were deposited in the Herpetological Collection of the San Diego Natural History Museum (**SDNHM**), San Diego, California, USA.

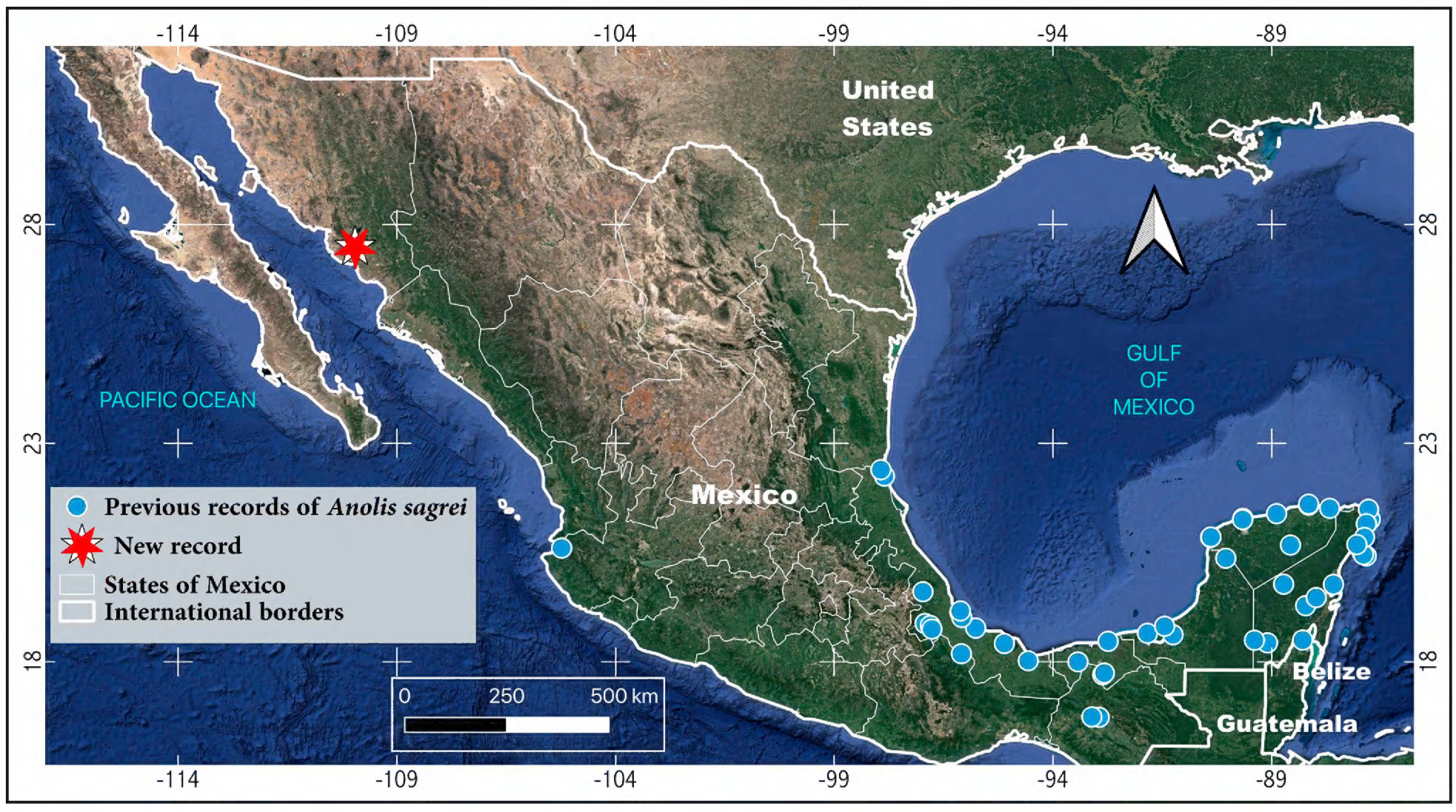

Figure 2. New record of *Anolis sagrei* in Sonora and previously reported localities in Mexico.

RESULTS

Anolis sagrei Dumeril & Bibron, 1837

New records. MEXICO – **Sonora** • Ciudad Obregón, Cajeme municipality; 27.4823°N, 109.9575°W; 36 m alt.; 04.V.2023, 14:18h; R.A. Lara-Resendiz & A.G. Perez-Delgadillo leg.; lassoed with fishing pole; 1 adult ♂, CH-UABC 2603 (Figure 1).

Photos of 12 individuals are in the SDNHM photo collection, catalog numbers SDSNH_HerpPC_05493 to 05504.

Identification. The collected specimen (Figure 1) was identified as an adult male of *A. sagrei* using the keys and descriptions provided by Köhler (2003). In adult males, the head is proportionally shaped, not excessively large or elongated; the dewlap is yellow-orange to red-orange with yellow edges; the SVL ranges from 50 to 70 mm. The legs are long, the tail is distinctly compressed laterally and has a crest of enlarged scales (especially visible in males); the belly has scales with a slight to marked keel; the supracaudal scales are of equal size; there are 0–1 scales between the supraorbital semicircles; the supraocular scales have keels; and males have enlarged postcloacal scales.

DISCUSSION

The record of *Anolis sagrei* closest to our observation was made by Pazos-Nava et al. (2019) in Puerto Vallarta, Jalisco, Mexico; their record is 900 km away from ours in a straight line, and it was the first verified record of the species on the Pacific coast of Mexico. Our new record represents a significant extension of the known geographic distribution of this exotic, invasive species and emphasizes the importance of continued research and monitoring of its presence in different geographic regions. Until now, there have been no observations of this species in data produced by citizen science, such as on the iNaturalist platform, in northwestern Mexico. In the state of Sonora, the only native species of anole lizard is *Anolis nebulosus* (Wiegmann, 1834), which has a gular coloration similar to *A. sagrei* (Köhler 2003). However, *A. nebulosus* is distinguished from other Mexican and Central American anoles by a combination of characteristics as detailed by Köhler et al. 2014 (selected characteristics for *A. sagrei* in parentheses). These include weakly to strongly keeled ventral scales, a patch of usually three greatly enlarged, smooth to rugose supraocular scales (versus a less distinct patch of five or more only moderately enlarged, keeled supraocular scales), 8–18 rows of slightly enlarged dorsal scales smaller than ventral scales, long hind legs with a ratio of shank length/SVL 0.21–0.25, longest toe of adpressed hind leg usually reaching to ear opening (versus usually reaching well beyond eye), a single elongated prenasal scale, and a male dewlap that is orange with or without a white anterior margin when alive (versus orange with a complete yellow margin). Furthermore, *A. nebulosus* exhibits smaller size with males measuring 43 mm in SVL and females measuring 39.5 mm (Köhler et al. 2014). In contrast, *A. sagrei* showcases larger dimensions, with males ranging from 65 to 70 mm SVL and females from 50 to 60 mm (Campbell 1998; Sexton and Brown 2007; Norval et al. 2012).

We suggest that the founding member(s) of the *A. sagrei* population in Ciudad Obregón were possibly displaced through the northwards transportation of plants native to the central and southern regions of Mexico (Mahrdt et al. 2014). The lizards could have adhered to leaves, stems, soil, and leaf litter of such plants, and even their eggs could have been transported along with them. The diverse ecosystems of central and southern Mexico host numerous plant species that could have potentially served as carriers for these organisms (Álvarez-Romero et al. 2008). Furthermore, human activities such as trade, agriculture, and horticulture are significant in the unintentional dispersal of species across geographic borders, inadvertently facilitating the establishment of lizard populations (Pergl et al. 2017).

Although *A. sagrei* has been introduced in sites with deciduous and semideciduous tropical forests, as well as tropical urban environments and disturbed areas near coasts (Álvarez-Romero et al. 2008; Delaney et al. 2014; Batista et al. 2019), it is noteworthy that Ciudad Obregón has a semiarid climate, with an annual mean temperature of 17.1 °C, average maximum temperatures of 32.2 °C, and an annual precipitation of 127 mm (Fick and Hijmans 2017). While lizards can adapt to varied environments, the survival of *A. sagrei* outside of the plant nursery where we found this species may be compromised due to the urban environment and the high temperatures recorded during the summer and at hours of peak insolation. We visited other nurseries with greater sun exposure and also explored the surrounding areas, such as the street, nearby park, and courtyard across the street, but did not observe *A. sagrei*. This species exhibits life history traits that allow it to quickly colonize sites beyond its natural geographic range. These lizards can reach sexual maturity in as little as three months, which is twice as fast as their congener *A. carolinensis* Voigt, 1832, which coexists with *A. sagrei* in Hawaii (Alascio 2022). Furthermore, populations of *A. sagrei* have been observed to rapidly increase their density. For example, Campbell and Echternacht (2003) estimated a population density of over 12,000 individuals per hectare just four years after its introduction to an island. The diet of *A. sagrei* is also notable, as this lizard primarily feeds on invertebrates but has also been found to consume other lizards and snakes, and it even displays cannibalistic behavior (Norval et al.

2002; Delaney et al. 2014; Orfinger 2018). Due to these characteristics, *A. sagrei* is a capable of altering the ecological balance of native reptile and invertebrate communities where it has been introduced (Campbell and Echternacht 2003). In Ciudad Obregón, native species such as *Urosaurus ornatus* (Baird & Girard, 1852) and *U. bicarinatus* (Duméril, 1856) can be found, which could potentially compete with *A. sagrei* (Rorabaugh and Lemos-Espinal 2016). Therefore, we recommend that measures are taken to control the presence of these lizards and prevent their arrival in tropical areas of southeastern Sonora, including, for example, a risk assessment, establishing monitoring programs, control, and eradication, as well as education and awareness initiatives.

ACKNOWLEDGEMENTS

AGPD thanks the Posgrado en Ciencias Biológicas, UNAM, and the support of CONAHCyT for the doctoral scholarship (817676). RALR acknowledges the support from PROFAPI-ITSON-2023-033-RALR. We would like to express our gratitude to the staff of the plant nursery in Ciudad Obregón for allowing us to search for lizards. The collecting permit (SPARN/DGVS/06916/23) was issued by the Dirección General de Vida Silvestre, México. We thank the Laboratorio de Vertebrados at the Facultad de Ciencias, Universidad Autónoma de Baja California for cataloging the specimen, and the San Diego Natural History Museum for cataloging the photographic vouchers. Finally, we thank the two reviewers for their contributions.

ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

Funding

This study was financially supported by CONAHCyT (817676) and PROFAPI-ITSON-2023-033-RALR.

Author contributions

Conceptualization: RALR, AGPD. Data curation: RALR, AGPD. Formal analysis: AGPD. Funding acquisition: RALR. Investigation: RALR, AGPD. Methodology: RALR, AGPD. Resources: AGPD. Visualization: RALR. Project administration: RALR. Writing – original draft: RALR, AGPD. Writing – review and editing: RALR, AGPD.

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Data availability

All data that support the findings of this study are available in the main text.

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